CONTRACT AND SPECIFICATIONS FOR THE CONSTRUCTION OF THE SUPERSTRUCTURE OF THE YOUGHIOGHENY BRIDGE, McKEESPORT, PA.

GENERAL DESCRIPTION.

Attached to and combined with these specifications is a blue print giving a skeleton plan and profile of the bridge, and also sections of the different floor systems.

Alignment.—The alignment from the west abutment of the bridge to the center of Pier No. 2 is a ten (10) degree curve to the right; thence a tangent to the center of Pier No. 3; thence a five (5) degree curve to the right to the center of Pier No. 4, there compounding with a seven (7) degree curve to the right, said seven (7) degree curve terminating in a tangent point ten (10) feet before reaching the face of the east abutment; thence tangent. The alignment thus noted is for the main line of the P., McK. & Y. R. R.

M. E. S. R. R.—On the west side, the Monongahela East Shore Railroad branches off to the right from the Pittsburgh, McKeesport & Youghiogheny Railroad with a ten (10) degree curve, beginning at the center of Pier No. 2, as shown.

Grades.—The grade from the west abutment to the center of Pier No. 3, is level; thence a descending grade of six (6) inches per hundred feet to the east abutment.

Spans Nos. 1 and 2.—Spans Nos. 1 and 2 are both on the ten (10) degree curve.

Span No. 1.—Span No. 1 measures ninety (90) feet on the chord from the face of the back wall of the west abutment to the center of Pier No. 1.

Span No. 2.—Span No. 2 measures ninety (90) feet on the chord from center of Pier No. 1 to center of Pier No. 2.

Span No. 3.—Span No. 3 measures two hundred and thirty-six (236) feet from center of Pier No. 2 to center of Pier No. 3.

Span No. 4.—Span No. 4 measures one hundred and thirty-seven (137) feet and six (6) inches on the chord of the five (5) degree curve from center of Pier No. 3 to center of Pier No. 4.

Span No. 5.—Span No. 5 measures one hundred and thirty-seven (137) feet and six (6) inches on the chord of the seven (7) degree curve from center of Pier No. 4 to center of East Shore Pier No. 5.

Span No. 6.—Span No. 6 measures sixty-eight (68) feet on the chord of the seven (7) degree curve from center of East Shore Pier No. 5 to center of next pier, No. 6.

Iron Trestle.—From end of span No. 6 to the east abutment, there are five spans of plate girders built on iron trestles, each span measured on the chord of the seven (7) degree curve. The first span is thirty-four (34) feet from center of pier No. 6 to first bent; then three (3) spans of thirty-two (32) feet each from center to center of bents; last span, thirty-six (36) feet from center of last bent to the back wall of the abutment, or thirty-two (32) feet and six (6) inches to the face of the abutment. By face of the abutment is meant the front of the wall under bridge seat coping, said coping projecting six (6) inches.

MASONRY.

West Abutment.—The west abutment has a bridge seat of five (5) feet, measured on the center line. The face of abutment is built askew to the tangent produced of span No. 3, at an angle of sixty-four (64) degrees.

Piers.—Piers 1, 2, 3 and 4 are built askew to tangent produced of span No. 3, at an angle of sixty (60) degrees; piers 5 and 6 at an angle of fifty-eight (58) degrees to the same line. All trestle piers built parallel to pier No. 6 and to the face of the east abutment.

Pier No. 1.—Pier No. 1 has a width of eight (8) feet on the top of the coping out to out, measured at right angles to axis of pier.

Piers Nos. 2 and 3.—Piers Nos. 2 and 3 are ten (10) feet wide on top of coping, at right angles to axis of pier.

Pier No. 4.—Pier No. 4 is nine (9) feet wide on top of coping, at right angles to axis of pier.

Pier No. 5.—Pier No. 5, or East Shore Pier, is seven (7) feet wide on top of coping, at right angles to axis of pier.

Pier No. 6.—Pier No. 6 is six (6) feet wide on top of coping, at right angles to axis of pier.

Trestle Footings.—Trestle footings will be composed of pedestal stones three (3) feet square, two (2) feet deep, having bases of five (5) feet square and two (2) feet deep, resting on a bed of concrete six (6) feet square and four (4) feet deep.

East Abutment.—East abutment, four (4) feet bridge seat.

Coping.—The coping projects over faces of walls in all cases, six (6) inches.

SPANS.

Spans 1 and 2.—Spans Nos. 1 and 2 are deck spans, having pin-connected trusses. Cross section trusses shown.

The floor beams to be iron plate girders, riveted to every post.

The stringers to be composed of packed I beams as shown; top of stringers level with top of chords.

Depth of Truss.—Depth of truss, ten (10) feet center to center of chords. Panels not over ten (10) feet long.

Depth of Floor Beams.—Depth of floor beams, eighteen (18) inches.

Depth of Stringers.—Depth of stringers, twelve (12) inches. The stringers to be composed of four twelve (12) inch light I beams, packed two together, as shown, and riveted to floor beams, the joints of the I beams to be broken and each I beam continuous for two panel lengths and joints spliced on both sides and well riveted.

Spans 1 and 2 to have top and bottom lateral bracing at each panel, with vibration rods at each panel point.

Ties.—Ties to be nine (9) inches wide with three (3) inches space between them, or twelve (12) inches from center to center, of best quality white oak, countersunk one-half (½) inch on top of stringers and top chord.

The bottom of ties to be level. The top of ties to be five and one-half (5½) inches above top of inside stringer and beveled out to out of chords sufficient to give one (1) inch elevation on outside rail. The full elevation to continue to the center of pier No. 2; then gradually decreasing to a point fifty (50) feet distant from pier No. 2, on span No. 3, where the rails are to be level. The center of track to be on the regular grade, the elevation to be obtained by raising the outside rail one-half (½) inch and depressing the inside rail one-half (½) inch.

Width of Truss.—Width between centers of trusses eleven(11) feet. The versed sine at the center of the span on the curve is about twenty-one (21) inches. The spans are to be so arranged as to have half of the versed sine taken up by the track at the center of the spans, and the other half at the ends of the spans. The parts of the trusses which receive the excess weight on account of the curve, to be increased in dimensions to allow for the increased weight of the moving load at those points.

Guards.—Guard rails to be placed at a distance of one (1) foot in the clear from the outside of the rails, composed of the best quality of white oak, eight (8) inches by six (6) inches in section; to be notched down one-half (½) inch on the ties and bolted to the top flanges of the floor beams with three-quarter (¾) inch bolts, and bolted twice through the ties between floor beams.

Gauge of Track.—The gauge of the track to be four (4) feet eight and three-quarters (8¾) inches on a tangent, and four (4) feet nine and three-quarters (9¾) inches on spans 1 and 2.

Span No. 2.—Span No. 2 shall be shown in two ways:

First, a detailed plan shall be shown for a single track for the P., McK. & Y. R. R.

Second, a detailed plan shall be shown of three trusses, so as to allow the connection of the M. E. S. R. R. with the P., McK. & Y. R. R., at the center of Pier No. 2, as shown in plan.

Span No. 3.—Span No. 3 measures two hundred and thirty-six (236) feet from center to center of Piers 2 and 3. The distance from inner edge of inclined end posts to center of track to be not less than seven (7) feet. The centers of trusses to be equally distant from center of track.

The south trusses of all through spans to be so arranged that if it is desired to double-track the bridge at any subsequent time, they can be replaced by heavier trusses and the old trusses moved out and placed in the proper position for a three-trussed double-track bridge; by this arrangement the floor beams will not be changed. The nearest edge of inclined end posts of heavy truss to be seven (7) feet from center of either track, and the outside trusses will be about seven (7) feet six (6) inches. Span No. 3 to be a double cancellated truss. Panels to be same length, measured on center of track. By this arrangement there will be a short panel at one end of each truss and a long one at the other end, the short panel in one truss being opposite the long panel in the other truss. Panels about sixteen (16) feet six (6) inches in length.

Floor Beams.—The floor beams to be placed at right angles to the center line of the track; to be composed of plate girders two (2) feet deep, suspended by wrought-iron plates from the chord pins, the plates being riveted to the floor beam, having several strengthening plates at the end of floor beams and a bent angle at the top of floor beams as shown.

Stringers.—Two longitudinal plate girder stringers, twenty (20) inches deep, to be riveted to floor beams, as shown; to be five (5) feet from center to center. The stringers to be covered with ties of best quality white oak, six (6) inches by nine (9) inches by nine (9) feet (except those as specially referred to for elevating track on spans 2 and 4), spaced twelve (12) inches, center to center.

Guards.—One foot distant in the clear outside of rails, guard timbers will be placed, eight (8) inches by six (6) inches in section, of best quality white oak, notched down one-half (½) inch on ties, supported by two lines of best quality white pine stringers.

Wooden Stringers.—The wooden stringers to be bolted at the ends to bent angle rests or chairs riveted to floor beams. The guards to be bolted to the wooden stringers on each side of each floor beam through the ties, wooden stringers and chair,

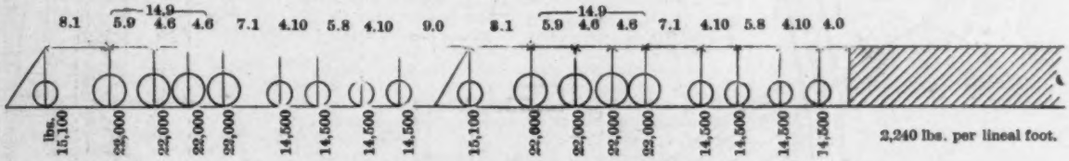


DIAGRAM SHOWING MOVING LOAD.

and twice between floor beams. The ties, as well as guards, to be counter-sunk one-half (½) inch. The wooden stringers to be six (6) inches by sixteen (16) inches in section.

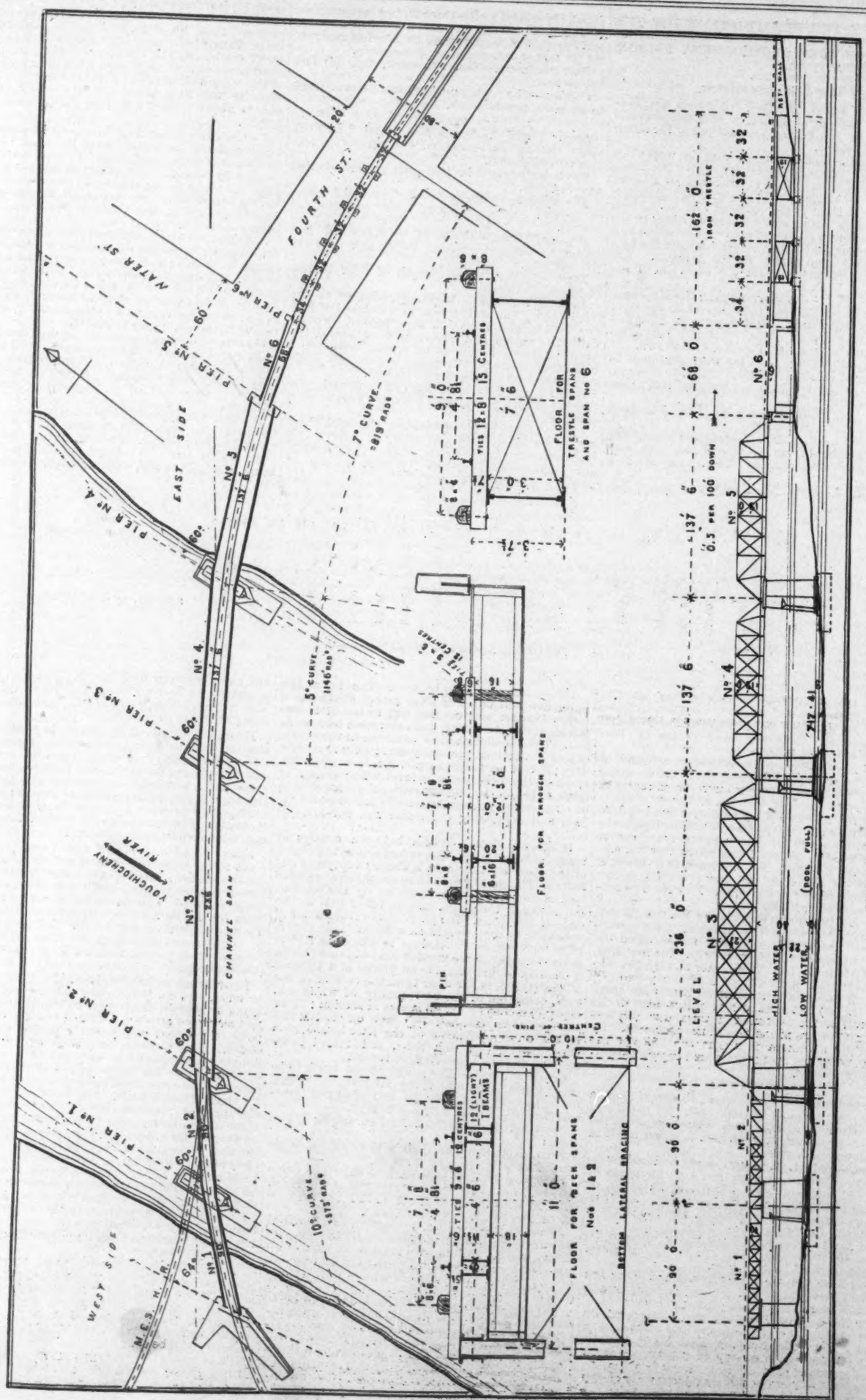
Posts.—The posts of trusses to be continued to the top of the floor beams. The trusses to be twenty-seven (27) feet deep, center to center of chords; to have lateral bracing between trusses at every panel, at a height of nineteen (19) feet from the base of rail to the bottom of braces; also, vibration rods between top chord bracing and intermediates. The trusses to be braced laterally at top, intermediate and at bottom.

Spans 4 and 5.—Spans 4 and 5 are practically alike so far as design of truss and length of spans are concerned, both single cancellated trusses, measuring one hundred and thirty-seven (137) feet six (6) inches on chords, center to center of piers. Span No. 4 is on a five (5) degree curve. Span No. 5 is on a seven (7) degree curve. The floor systems to be the same as on span No. 3, likewise the arrangement of panels, which will be about fifteen (15) feet long.

Floor beams to be at right angles to center line of truss. At no point, either at the ends of the spans or centers, shall there be less than seven (7) feet clearance between center of track and nearest point of inclined end posts or projection of top chord. The same arrangement of trusses for double tracking shall be as provided in span No. 3. The trusses bearing an excess of moving load, owing to the curve, shall have their parts increased for the additional loads. The outer rail to have an elevation of three-quarter (¾) inches over the inner rail on both spans. The center of track being on the regular grade. The elevation being made in the ties, as mentioned in spans Nos. 1 and 2. The elevation of outer rail commencing fifty (50) feet back on span No. 3. Trusses for spans 4 and 5 to be nineteen (19) feet deep from center to center of chords, with top and bottom lateral bracing.

The clearance way from the base of rail to the bottom of any overhead intermediate bracing or top lateral bracing, in all through spans, shall be nineteen (19) feet.

Span No. 6.—Span No. 6 to be a deck span composed of two iron plate girders, six (6) feet deep, seven (7) feet six (6) inches between center of girders. Floor system as shown in sketch marked "Floor for Trestle Spans and Span No. 6." The girders arranged to have the versed sine of curve at center of span half overcome at ends of girders and half in the center, as there is a versed sine of about eight (8) inches, the span should be placed about four (4) inches out of center at both ends.



YOUGHIOGHENY RIVER BRIDGE, McKEESPORT, PA.

The girders to be well braced laterally, top and bottom, and also to have vibration rods.

The trestles to be all of the same height, fifteen (15) feet seven and one-half (7½) inches from the base of rail to top of pedestal blocks. The spans to be as shown. All plate girders to be three (3) feet deep and seven (7) feet six (6) inches between centers, having top and bottom lateral bracing and vibration rods. The floor system composed of best quality white oak; minimum size being eight (8) inches by twelve (12) inches in section and about nine (9) feet eight (8) inches long, varying in length to suit the curve, projecting outside of girders, as shown; spaced three (3) inches apart, or fifteen (15) inches center to center, notched down on the girders, the outer rail elevated three-quarters (¾) inches. Elevation made in ties, as mentioned previously in spans 1, 2, 4 and 5.

Guards.—Guard rails eight (8) inches by six (6) inches, best quality white oak, as shown, placed on outside of girders, notched one-half (½) inch on ties, and bolted to every sixth tie with three-quarters (¾) inch bolts. Two spans of the iron trestle to be braced, as shown, longitudinally and diagonally. Each bent to have horizontal cross-bracing, top and near bottom, and to have vibration rods. The foot of each post to have a large base, bolted to pedestal block with two one (1) inch bolts.

Material.—All parts of the superstructure to be composed of wrought iron, except bed-plates and washers, which may be of cast iron.

Strain Sheets.—Contractors must submit with their proposals full strain sheets for each span. The strain sheets must show for each member of every truss the total strain sustained, and the net dimensions and area of cross-section; also, the dead weight assumed in the calculation, and the resulting weight of the structure, which must not be more than the dead weight assumed. In calculating strains, the length of span shall be understood to be the distance between centers of end pins for trusses and between centers of bearing plates for all beams and girders.

The contractor will be required to furnish and build the total superstructure in place, including ties, guard rails and wooden stringers—everything but the rails.

Loads.—The entire bridge will be proportioned to carry the following loads:

Dead Load.—1st. The weight of iron in the structure.

2d. A floor weighing four hundred (400) pounds per lineal foot of *track*, to consist of the rails, ties, guard timbers and wooden stringers only.

These two items to constitute the "dead load."

Moving Load.—3d. A moving load, consisting of two "consolidation" engines, coupled, followed by a train weighing one gross ton per lineal foot. This "live load" being concentrated upon points distributed as in the diagram.

The maximum strains due to all positions of the above "live load" and to the "dead load" shall be taken to proportion all parts of the structure.

Wind Strains.—To provide for wind strains and vibrations, the top lateral bracing in deck spans and the bottom lateral bracing in through spans shall be proportioned to resist a lateral force of five hundred (500) pounds for each foot of the span, three hundred and fifty (350) pounds of this to be treated as a moving load. The bottom lateral bracing in deck spans and the top lateral bracing in through spans to be proportioned to resist a lateral force of one hundred and fifty (150) pounds per lineal foot of span. Variations in temperature to the extent of one hundred and fifty (150) degrees shall be provided for in all parts of the structure. All parts shall be so designed that the strains coming upon them can be accurately calculated.

PROPORTION OF PARTS.

1. *Tensile Strains.*—All parts of the structure shall be so proportioned that the maximum strains produced shall in no case cause a greater tension than the following:

	Lbs. per sq. in.
On lateral bracing	12,000
Bottom chords and main diagonals	10,000
Counter-rods and long verticals	8,000
Bottom flange of floor beams and stringers	7,000
Bottom flange of plate girders in span No. 6 and iron trestle	8,000

2. *Compressive Strains.*—Compression members shall be so proportioned that the maximum load shall in no case cause a greater strain than that determined by the following formulæ:

$$P = \frac{8{,}000}{1 + \frac{L^2}{40{,}000R^2}}$$ for square end compression members.

$$P = \frac{8{,}000}{1 + \frac{L^2}{30{,}000R^2}}$$ for compression members with one pin and one square end.

$$P = \frac{8{,}000}{1 + \frac{L^2}{20{,}000R^2}}$$ for compression members with pin bearings.

P = the allowed compression per square inch of cross-section.

L = the length of compression member in inches.

R = the least radius of gyration of the section in inches.

3. The lateral struts shall be proportioned by the above formulæ to resist the resultant due to an assumed initial strain of ten thousand (10,000) pounds per square inch upon all the rods attaching to them, produced by adjusting the bridge.

4. In girders, compression shall be limited as follows:

In riveted plate girders used as cross floor beams, gross section, 6,000 pounds per square inch.

In riveted longitudinal plate girders, over twenty (20) feet long, gross section, 6,000 pounds per square inch.

In riveted longitudinal plate girders, under twenty (20) feet long, gross section, 5,000 pounds per square inch.

5. *Variable Strains.*—Members subjected to alternate strains of tension and compression shall be proportioned to resist each of them. The strains, however, shall be assumed to be increased by an amount equal to four-fifths (⅘) of the least strain.

6. *Shearing Strains.*—The rivets and bolts connecting all parts of the girders must be so spaced that the shearing strain per square inch shall not exceed six thousand (6,000) pounds, nor the pressure upon the bearing surface exceed twelve thousand (12,000) pounds per square inch of the projected semi-intrados (diameter × thickness of piece), of the rivet or bolt hole.

7. *Strains on Pins.*—Pins shall be so proportioned that the shearing strain shall not exceed seven thousand (7,000) pounds per square inch, nor the crushing strain upon the projected area of the semi-intrados (diameter multiplied by thickness of piece), of any member connected to the pin, be greater than twelve thousand (12,000) pounds per square inch; nor the bending strains exceed twelve thousand (12,000) pounds per square inch on the top chord pins; nor fifteen thousand (15,000) pounds per square inch on the bottom chord pins, when the centers of bearings of the strained members are taken as the points of application of the strains.

8. *Plate Girders.*—Plate girders shall be proportioned upon the supposition that the bending or chord strains are resisted entirely by the upper and lower flanges, and that the shearing or web strains are resisted entirely by the web plate.

9. *Staying of Compression Flanges.*—The compression flanges of beams and girders shall be stayed against transverse crippling when their length is more than thirty times their width.

10. *Width of Plates.*—The unsupported width of any plate subjected to compression shall never exceed thirty times its thickness.

11. *Net Sections.*—In members subject to tensile strains full allowance shall be made for reduction of section by rivet-holes, screw threads, etc.

12. *Web Sections.*—The iron in the web plates shall not be subjected to a shearing strain of more than four thousand (4,000) pounds per square inch, and no web plate shall be less than three-eighths (⅜) of an inch in thickness.

DETAILS OF CONSTRUCTION.

1. *Connections.*—All the connections and details of the several parts of the structure shall be of such strength that, upon testing, rupture shall occur in the body of the members rather than in any of their details and connections.

2. *Accessibility.*—Preference will be had for such details as will be most accessible for inspection, cleaning and painting. No closed work will be allowed in the structure.

3. *Web Joints.*—The webs of plate girders must be spliced at all joints by a plate on each side of the web. T-iron must not be used for splices.

4. *Stiffening of Webs.*—When the least thickness of the web is less than one-eightieth (1/80) of the depth of a girder, the web shall be stiffened at intervals not over twice the depth of the girder.

5. *Pitch of Rivets.*—The pitch of rivet in all classes of work shall never exceed six (6) inches, nor sixteen times the thinnest outside plate, nor be less than three diameters of the rivet.

6. *Diameter.*—The rivets used will generally be three-quarters (¾) inches and seven-eighths (⅞) inches in diameter.

7. *Rivet Holes.*—The distance between the edge of any piece and the center of a rivet hole must never be less than one and one-quarter (1¼) inches, except for bars less than two and one-half (2½) inches wide; when practicable, it shall be at least two (2) diameters of the rivet.

8. *Wide Flanges.*—When plates more than twelve (12) inches wide are used in the flanges of plate girders, an extra line of rivets with a pitch of not over nine (9) inches shall be driven along each edge to draw the plates together and prevent the entrance of water.

9. *Punching.*—In punching plate or other iron the diameter of the die shall in no case exceed the diameter of the punch by more than one-sixteenth (1/16) of an inch.

10. All rivet holes must be so accurately punched that when the several parts forming one member are assembled together, a rivet one-sixteenth (1/16) inch less in diameter than the hole can be entered hot, into any hole without reaming or straining the iron by "drifts."

11. The rivets, when driven, must completely fill the holes.

12. *Rivet Heads.*—The rivet heads must be hemispherical, and of a uniform size for the same-sized rivets throughout the work. They must be full and neatly made, and be concentric to the rivet hole.

13. *Machine Riveting.*—Wherever possible, all rivets must be machine driven.

14. *Built Members.*—The several pieces forming one built member must fit closely together, and when riveted shall be free from twists, bends and open joints.

15. *Joints.*—All joints in riveted work, whether in tension or compression members, must be fully spliced, as no reliance will be placed upon abutting joints. The ends, however, must be dressed straight and true, so that there shall be no open joints.

16. *Lower Chords and Suspension Bars.*—The heads of eye-bars shall be so proportioned that the bar will break in the body instead of in the eye. The form of the head and the mode of manufacture shall be subject to the approval of the Chief Engineer. Each proposal to be accompanied by a statement giving method of manufacture of eye-bars.

17. The bars must be free from flaws and of full thickness in the necks. They shall be perfectly straight before boring. The holes shall be in the center of the heads and on the center line of the bar.

18. The bars must be bored of exact lengths, and the pin holes one sixty-fourth (1/64) of an inch larger in diameter than the pins.

19. *Packing Pins.*—The lower chords shall be packed as narrow as possible.

20. The pins shall be forged and turned straight and smooth, and shall fit the pin holes within one-sixty-fourth (1/64) of an inch.

21. The diameter of the pin shall not be less than two-thirds (⅔) the largest dimension of any tension member attached to it. Its effective length shall not be greater than the breadth of the foot of the post plus four times the diameter of the pin. The several members attaching to the pin shall be packed close together, and all vacant spaces between the chords and posts must be filled with wrought-iron filling rings.

22. *Upset Ends.*—All rods with screw ends shall be upset at the ends so that the diameter at the bottom of the threads shall be one-sixteenth (1/16) inch larger than any part of the body of the bar.

23. All threads must be of the United States standard, except at the ends of the pins.

24. *Floor Beam Hangers.*—Floor beam hangers shall be so placed that they can be readily examined at all times.

25. *Compression Members.*—Compression members shall be of wrought iron, of approved forms.

26. *Pitch of Rivets.*—The pitch of rivets for a length of two diameters at the ends shall not be over four times the diameter of the rivets.

27. The open sides of all trough-shaped sections shall be stayed by diagonal lattice work at distances not exceeding the width of the member. The size of bars shall be duly proportioned to the width.

28. *Pin Holes.*—All pin holes shall be reinforced by additional material so as not to exceed the allowed pressure on the pins. These reinforcing plates must contain enough rivets to transfer the proportion of pressure which comes upon them.

29. Pin holes shall be bored exactly perpendicular to a vertical plane, passing through the center line of each member when placed in a position similar to that it is to occupy in the finished structure.

30. *Abutting Joints.*—The ends of all square-ended members shall be planed smooth and exactly square to the center line of strain.

31. All members must be free from twists or bends. Portions exposed to view shall be neatly finished.

32. *Lateral Bracing.*—In no case shall any lateral or diagonal rod have a less area than three-quarters (¾) of a square inch.

33. The attachment of the lateral system to the chords shall be thoroughly efficient. If connected to suspended floor beams, the latter shall be stayed against all motion.

34. *Transverse Diagonal Bracing.*—All through spans with top lateral bracing shall have wrought iron portals, of approved design, at each end of the span, connected rigidly to the end posts. The diagonal bracing at the ends of all spans shall be of the same equivalent strength as the end top lateral bracing.

35. *Bed Plates.*—All bed plates must be of such dimensions that the greatest pressure upon the

Continued on page 59.

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Correspondence upon subjects which naturally belongs to the province of this journal is solicited.

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NOTICES OF MEETINGS.

THE AMERICAN WATER-WORKS ASSOCIATION.—The second annual meeting of the American Water-Works Association will be held in the City Hall, Columbus, O., on Tuesday, March 14, 1882. J. H. DECKER, Secretary.

THE SUBSCRIPTION SEASON of most newspapers and periodicals is comprised in the first two months of the year, and by the results of these two months' business the publishers largely test the progress they are making and their readers' appreciation of their past labors. It is to the publisher very much what the periodical election is to the politician. We are pleased to be able thus early in the season to extend our thanks to the "old" subscribers to ENGINEERING NEWS for the universal promptness with which they have sent in their renewals for the current year, and it is an additional cause for self congratulation to count up the long list of new names that "somehow" have seen or heard of the paper, and esteeming it just what they want, have subscribed. In the six weeks of the present year we have taken as many new subscribers as we have usually considered a good six months' showing, and the rate of increase we are happy to say does not show any abatement as yet. One of the results of this happy state of affairs is the already total demoralization of our file of back numbers, for which we thought we had quite amply provided for months to come. Owing to the increase of new subscribers and to the demand for special numbers we are now unable to furnish a full file from the beginning of the volume except as we can buy certain numbers back from such of our subscribers as do not care to preserve them. Now, we are very much pleased to note the increasing popularity of ENGINEERING NEWS, and it is the great incentive to do more and better than we have done heretofore. We honestly think that, without fear of contradiction, we can claim ours to be *the* journal of the engineers and contractors of America, and to our columns we expect, and everybody else who knows "what's what" expects, to look for the latest and most complete record of the constructive work of the continent. "Business," first, last and all the time, is what we are after: how to make money and how to help others to make it, is our aim, and if this is looked upon as sordid, etc., by any "super-æsthetical, highly poetical" engineer or contractor, if such an one there be, we must bear up under it as best we may, and continue to hunt up projects, new and old, whereby our readers may get hold of some "lucre" if possible. The present season will be one of immense activity; engineers will be in demand; contractors will have all they can attend to; and we propose to be "up to the times" if money, brains and industry will effect it.

NEW CROTON AQUEDUCT.

There have been some conflicting opinions as to the competency of the Croton water-shed to supply the city of New York with water under all meteorological conditions, and surveys have been made looking to the introduction of the Housatonic River, which, however, lying in an adjoining State, might involve some legal complications before it could be effected; in any event, it would be desirable, if possible, not to look beyond our own territory for the water supply of our metropolis.

A consideration of the rainfall and the measured amount of water which has passed over the Croton dam for a series of years would indicate that unless the demand for water in the future exceeds all reasonable computation the Croton water-shed could, by a judicious system of storage reservoirs, be anticipated to meet all the demands likely to arise in this city for many years to come. If the use of the water were confined to its legitimate purpose, that is to say, to meet the domestic wants alone of the population, it could answer all the demand, under a properly regulated administration, of a city of at least 3,000,000 of people for a generation to come. But the enormous and increasing demands for water for manufacturing purposes will diminish proportionately the extent of population which could be supplied. The ultimate use of salt water for many purposes is a mere question of time, however.

From 1866 to 1880 it appears that the flow from the Croton water-shed averaged for the year as high as 600,000,000 gallons, and for no year was it less than 300,000,000 gallons daily. Setting aside the surplus of the years of greatest rain, and assuming that water could not be stored from the overplus of one year for use in the next, but that in each year the excessive rains could be stored only to the extent of supplementing the deficiencies of the current year, it appears that the basin could, with such storage, furnish 250,000,000 gallons for each and every day in the year, and to insure that daily supply a storage capacity of near 50,000,000,000 gallons would be sufficient.

It is not to be expected that the entire rainfall in years of excessive rains can be stored. Storms occurring when the reservoirs are full must run to waste, but this has been considered in the statement above of 250,000,000 gallons daily.

The fact that the existing aqueduct is heavily taxed to bring 100,000,000 gallons into the city, and if it were a safe structure and to be relied upon to that extent, which is far from the fact, still a new conduit would be needed in the early future, as the present one limits the city supply to less than half the water available from the Croton shed; and this fact had led the authorities to survey and estimate the cost of a new conduit; and a bill to authorize its construction was passed by the Legislature of 1881, but which failed to receive the Governor's sanction, on the alleged ground that the bill, as drawn, did not limit the amount which the city was authorized to expend under it, the estimate of its cost varying at different times from $12,000,000 to $20,000,000.

That this cause shall no longer operate to prevent the present Legislature from granting to the city the requisite authority, the present Commissioner of Public Works, Mr. Hubert O. Thompson, has caused detailed surveys and estimates to be made during the past year under the direction of the Chief Engineer, Isaac Newton, of the cost of a new aqueduct, capable of bringing to the city daily 250,000,000 gallons of water; an application will be made to the present Legislature for the requisite authority to construct, not an aqueduct merely, but this aqueduct, whose main feature will be, in connection with its dam, to utilize the entire rainfall of the Croton shed without other storage reservoirs than that offered by the dam itself. The storage reservoirs already constructed cost at the rate of about $200 for every million gallons stored. Subtracting the amount of storage capacity already secured or provided for, viz., thirteen thousand million gallons, leaves about thirty-seven thousand million gallons to be provided.

The proposed new dam, located on the Croton River, about 4½ miles below the present Croton dam, is a high masonry dam, giving a depth of water at the site of 185 feet, with a storage capacity estimated at near 33,000 millions of gallons, and an additional area of shed, of near 23 square miles.

The cost of this amount of storage, by the method now pursued, would amount to $6,000,000. By the location and height of the proposed dam, this same amount of storage is had at the cost of constructing the dam, and the attendant land damages, estimated at a little over $3,000,000. The proposed aqueduct will extend from near the new dam, in a very direct line towards the High Bridge, this directness, and its consequent saving in distance, being effected by constructing it for nearly the entire distance in tunnel, and in order that the estimate may be in excess of the actual cost the excavation has been estimated as rock throughout.

In introducing water from the Gunpowder into Baltimore, completed in 1878, the entire distance, nearly 8 miles, is tunneled in rock, mostly gneiss, similar to the formation in this neighborhood, but deeper shafts were then found necessary, and as the dimensions there adopted for the tunnel excavation were precisely the same as is proposed here, viz., a circular tunnel of 14 ft. in diameter, and lined with 2 in. of brickwork laid in cement, the record of the cost and time necessary for completion between shafts on that work became a guide, which has proved of great service in approximating to the actual cost which may be anticipated here; and, in addition to this precaution, in order that the cost may be within the estimate, it has been assumed that the excavation will require a lining of 12 in. of brickwork, although it is anticipated that much of the rock will be sound enough to render the lining of brick unnecessary.

The grade of the aqueduct of 9 in. per mile will give a delivery to the Central Park reservoir of 240,000,000 gallons daily without running under pressure.

By tapping the Croton River at a point 4½ miles nearer New York, and by the saving of distance effected by tunnel construction, the length of the aqueduct will be shortened from that of the present aqueduct by nearly six miles.

The project commends itself to the favorable opinion of the public int rested in pure water—plenty of it, and comparative freedom from accidental interruption to its use, and also actual economy beyond that of any other project which has been brought forward for the water supply of this city. This plan might be thought by some of doubtful feasibility, and at first sight its apparent boldness is rather startling, but there is nothing connected with the project which has not been successfully carried out elsewhere, with the single exception that the proposed dam is some 20 feet higher than any known construction for similar purpose. Stone dams have been successfully built and in use for years, of 160 feet in height, notably at Furens in France, and no practical difficulty whatever exists for carrying them 25 feet higher. With the improvements introduced of late years in the machinery applicable to all branches of construction, neither the tunnel nor the dam offer any obstacle to its successful and economic construction, or to accuracy in estimating the time and cost necessary to its completion.

The site of the dam has been thoroughly examined by boring, and shows a continuous rock foundation, in a comparatively narrow valley with abrupt side slopes abounding in rock suitable for such masonry as is proposed. Nor is the land flooded, notwithstanding its proximity to the city, either very valuable for farming or building purposes.

And the principle of tunneling for the line of conduit instead of making open cuts and embankments has many advantages without adding to the aggregate cost; and, if thought desirable, could be continued under Harlem River instead of by an elevated aqueduct on arches, and at less cost than the latter, as sound rock occurs in the bed of the river at the crossing, rendering it but little more expensive to tunnel than the same length on the remainder of the line of aqueduct.

The aggregate cost of the contemplated work, including the largest possible margin for contingencies, is $14,000,000, which embraces the entire work to the reservoir in Central Park.

GREAT MORTALITY IN BUFFALO.

THE CITY DECLARED TO BE ONE OF THE MOST UNHEALTHY IN THE UNITED STATES.

A Buffalo dispatch of the 12th to the New York *Times* says: "The Health Physician reports that Buffalo has become one of the most unhealthy cities in the United States. The present death-rate is double what it was a year ago. The report of the National Board of Health, compiled from the mortuary statistics of the chief cities of the nation for the past 13 weeks, shows that the death-rate of Buffalo has reached the alarming figure of 39 per 1,000. Small-pox, typhoid fever, diphtheria, scarlet fever, measles, cerebro-spinal meningitis, and all forms of zymotic disease, are having deadly sway in our midst, while consumption is claiming an unusually large number of victims. The open winter has had something to do with the alarming increase in mortality, but, as a matter of fact, the sanitary condition of the city is bad. The Fifth Ward is a hotbed of fever in every deadly form, for which the presence of cattle barns in the midst of densely populated neighborhoods and the absence of adequate sewerage are largely responsible. It is a stern truth which cannot be controverted that the National Board ranks it with the most unhealthy cities. The barns referred to are maintained by certain distilleries and the cattle are fed on distillery slops. These cattle are in such a condition that the stench from them is unbearable. They get sick from the stuff they are fed on and lie in thick mud. What is done with them is a mystery.

The sewers get choked with the filth that is drained into them from these pens, and when heavy rains come the houses in the vicinity become saturated with this foul mass, creating an odor that is perceptible for a long distance. On some days the people are obliged to close their little homes and escape to some place where they can breathe untainted air. They dare not open their windows for ventilation, for the air comes in laden with poisonous exhalations. In one block more than 40 persons are prostrated at the present time with fevers.

[Buffalo has no one to thank but herself for this, in listening to self-elected committees, who have delayed the abatement of the notorious Hamburgh Canal nuisance until such time as they can themselves be brought by dire experience to understand the value of the plans reported upon by sanitary engineers as essential to the health of the city.

Of all the cities in our country, we know of none the surroundings of which would seem to be so well suited to the highest sanitary attainment as that of Buffalo.

Situated on the shore of a wide, deep, and rapid river, having a current of from 6 to 10 miles per hour, furnishing a vehicle for the complete removal, and indeed the destruction, of anything cast into it, with ample slope for surface drainage of the city. An inexhaustable supply of water at her very door. The direction of the prevailing wind (rarely so gentle as a breeze) being directly from the ocean expanse of the lake, tending to sweep away any unwholesome exhalations, and all of no use so long as man, in his stupidity, will continue to ignore the teachings of experience, if they point to the necessity of parting with his dollars.

And here comes in the evils of quackery. Of all localities which occur to us, Buffalo is the least suited to the requirements of what is called the "separate system" of sewering. But in ignorance of its needs and necessities, and assured by interested parties of its greater economy, and filled with the idea that it was a new method of sewering, and so an improvement on existing methods, some of its citizens have had sufficient influence to throw obstacles in the way of the authorities, who, under professional advice, were prepared to inaugurate the system of sewerage, which, in accordance with the experience of older cities, would have removed the impediment which now exists to the proper sanitary condition of the city, viz., the Hamburgh Canal waters, which now reek with the pollution from the worst portions of the city, and the necessary cost of proper proceedings for the purification of this canal on the combined system is said by these quidnuncs to be so greatly in excess of the separate system, or new method, as they call it, that until more light is had on the subject, or, in other words, until they are themselves educated up to the standard of their neighbors, nothing shall be done. Much as we would deplore the sacrifice of young and innocent lives, we cannot but hope that it will be productive of good. Nothing short of such a visitation as they have had would have opened their eyes to the dangers of a *little* knowledge of an intricate subject.]

SEWERAGE AND DRAINAGE.

Property owners in town and country will be glad to learn that these two practical questions, which belong to the health and comfort of every householder in the State, are receiving the attention due to their importance. Prof. Gardner, chief of the New York State Survey and ex-member of the State Board of Health, has just made a valuable report to the State Board. Part of his report is based upon recent careful examinations in England, and part of it upon examinations and reports in the United States. His conclusions are that the combined system of sewerage is everywhere a failure. In London and Manchester it is pronounced a total failure by the best English engineers, and what is true of London and Manchester under like conditions is also true of the rest of the world.

The saving in expense of the lesser or single system is from one-half to three-fifths of the expense of the combined system. The best example of success in the new system is the city of Memphis, which is attracting almost as much attention in England as in the United States. What cost in Memphis about $137,000 in separate small sewers, would have cost from $837,000 to $2,125,000 for what is known as the combined sewer system, according to the estimates made at the time. In this respect, for what has been done, Memphis has so far proved an example to all the world. In Rochdale, France, (?) a like success has attended the experiments made. The separate and small sewers are for homes and places of business, and when the storm waters cannot be carried off on the surface, they should be provided for separately, but as a law the storm sewerage should have no connection with the homes of the people.—*Mail and Express.*

Every householder in the State, both town and country, will be glad to learn that so distinguished a scientist and sanitarian as an ex-member of the State Board of Health has had their comfort in view in some late studies of his abroad. With this pleasing assurance, there will be mingled, we regret to say, a feeling of sadness that such transcendent talents as those shown by the ex-member of the State Board of Health, in concluding from his personal observations that, what fails of success in London and Manchester is worthless the world over, should receive so little consideration from the public that their possessor should be put in charge of a topographical survey merely, instead of some more immediate application to the comfort and health of all the householders of the State, of the results of his wonderfully close observations abroad, by being charged with the supervision of the sewerage and drainage of the State generally; instead of, as at present, merely mapping out some of its waste lands. With this sadness, fortunately, will come the soothing reflection that it is just possible the distinguished ex-member of the State Board of Health has made a slight mistake in drawing his deductions—possibly has got his facts a little mixed—mayhap, has not the facts at all—and so the householder may be content with the assurance in his own mind, that the sole fact which appears in the case is the one that the ex-member of the State Board of Health is, after all, well placed, and no injustice is done him by committing to him the surveying of the waste lands of the State, as business well suited to his talents.

It seems that "the best example of success in the *new* system of sewerage is the city of Memphis, which is attracting almost as much attention in England as in the United States."

In the first place, it is by no means a *new* system, but has been recommended by engineers, wherever the circumstances of the locality called for it for the last 30 years (vide Rudolph Hering's report to National Board of Health, ENGINEERING NEWS, Jan. 28, 1882), and in the case of Memphis is incomplete in that the city is sewered (after a fashion) but is not drained at all. Wherever drainage is as necessary as sewerage, which is the case in large cities, the separate system, to be as complete and as efficacious as the combined, is more expensive than the latter. (Vide same Report of Hering's.) As to the system adopted in Memphis being "an example to the whole world," we only know that it is not the fault of the designer, if it be not, as he loses no opportunity to sing its praises in more of the languages of Europe than we can comfortably master.

That the sewering of the town of Rochdale, in France, should be held up as an example of the benefits to the rest of the world, to be anticipated from following the example of the City of Memphis, in its system of sewerage, may be a discovery of the distinguished ex-member of the State Board of Health and Chief of the New York State Survey, but it will fail to strike the ordinary mind in that light.

BROOKLYN ELEVATED ROADS.

The judges, Barnard, Gilbert and Dykeman, composing the general term of the Supreme Court have rendered their decision refusing to grant the right to the East River Bridge & Coney Island Rapid Transit Company (Culver's road) to build an elevated road on Water, Washington, High, Willoughby and Pearl streets and Flatbush, Fifth and Seventh avenues.

Summed up, the grounds upon which the adverse opinion is based is as follows:

First.—That compensation is not assured.

Second.—That construction of an elevated railway on city streets, without compensation, is confiscation.

Third.—There is not disclosed a public necessity sufficient to justify the court in permitting the erection of this railroad against the dissent and opposition of more than one-half of the owners of property along its line.

Work would have been commenced on the road forthwith, but this action of the court may be regarded as disposing of the case beyond any further controversy, as under a late decision of the Court of Appeals, "where the decision of the general term involves no point of law such decision cannot be reviewed."

There is a happy uniformity of opinion in our sister city that rapid transit is absolutely essential to its future interests. Something must be done to induce the overflow from New York to occupy these vacant lots, already sewered, curbed, lighted, paved and watered, but vacant, ready for owners to build. If they could but get to their places of business in New York within the same space of time that they reach Westchester there would be an inducement to take up their homes in Brooklyn, but failing this assurance, small merchants and mechanics whose business is in New York, very naturally, wish to be as near in *time* as possible to their business, and will not look to Brooklyn as long as there is a vacant lot in the upper part of New York island.

The mayors, influential citizens and the press of Brooklyn frequently break out in eulogies of a system of rapid transit which shall accommodate their outlying districts without interfering in any way with the streets or property near the center of the city, whose occupants are happily so situated as not to need such facilities, and are complacently looking for the advent of some genius in their midst who will solve this intricate problem for them. In the meantime, waiting this advent, they have defeated every feasible scheme offered, whereby capital could be induced to test what at the best would be but an experiment, so far as a return on capital invested in rapid transit is concerned, and they now have the prospect of waiting a while longer. When the bridge is opened, however, we shall find some of the demagogues and interested individuals who have been loudest in opposing everything which did not pay prospective damages for the use of the streets, in something of a quandary; unless with great inconsistency, they admit that some one may with propriety be hurt for the good of the majority; they will find themselves with an elephant on their hands, useful, it is true, like Barnum's, in making a *big show.*

PERSONAL.

COUNT DE LESSEPS is reported seriously ill at Cairo.

MR. HENRY M. WIGHTMAN has been re-elected City Engineer of Boston.

GENERAL ROSSER, chief engineer of the Canada Pacific Railway, has resigned.

C. A. ALLEN has been unanimously re-elected City Engineer of Worcester, Mass.

MR. THOS. H. TRACY has been appointed City Engineer of London, Ont., at a salary of $2,400 per annum. He is the first permaneut engineer that has held the position.

MR. F. J. SMITH, who was constructing engineer for Henry R. Worthington for thirteen years, has accepted the position of Chief Mechanical Engineer of the St. Joseph (Mo.) Water-Works.

JACOB GESSERT, late Superintendent of Police of Cincinnati, O., committed suicide on the 15th inst. Mr. Gessert served several years as a member of the Board of Public Works of Cincinnati. He leaves a wife and nine children.

MR. CHARLES W. STEVENS, formerly of San Francisco, died on the 13th at 165 East Twenty-seventh street, this city, where he has been living for the past four months with his family. Mr. Stevens was a civil engineer and master mechanic. He built the first locomotive run in California, and superintended the building of the first railroad in Oregon. The remains will be taken to Concord, N. H.

ENGINEERS' SOCIETIES.

AMERICAN SOCIETY OF CIVIL ENGINEERS.

Feb. 15, 1882, the Society met at 8 p. m., President Welch in the chair.

A paper by Mr. R. E. McMath, of St. Louis, member of the Society, subject, "The Mean Velocity of Streams Flowing in Natural Channels," was read by the Secretary in the absence of the author. With this paper was presented a set of diagrams of curves, deduced from the experiments of J. B. Francis, member A. S. C. E., at Lowell, from the observations of Gen. Theo. G. Ellis, member A. S. C. E., upon the flow of the Connecticut River; from the records of the flow of the Mississippi, made by Gens. Humphreys and Abbott, and also from various other observations of the flow of the Mississippi at Columbus, Ky.; at Vicksburg, Miss.; at Carrollton, La., and at the Passes at the mouth of the Mississippi.

The author of the paper then presents for consideration and discussion the suggestion that to determine a reliable rule for the flow of streams in natural channels, the considerations affecting an artificial channel should be kept entirely distinct, that the definite law of discharge over a weir is usefully applicable at any transverse section above and within the influence of the weir, dam or shoal; that the relation between mean and maximum velocity cannot be used in streams of irregular section; that head is pressure, but not in all cases fall of surface; that in natural streams, the bars or shoals are substituted for the weir or dam; that the level of no discharge is determined by the horizontal plane through the crest of a weir, dam or natural bar; that two new hydraulic terms may be used, viz.: Permanent area, or that part of transverse section below the plane of no discharge, and ruling depth, or depth of the plane below the surface. Formulæ are then suggested in application of these considerations. The paper was discussed by Messrs. T. C. Clarke, Ashbel Welch, F. Collingwood, Joseph P. Davis and Charles E. Emery.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.

Continued from page 51.

CC.—MEDFORD.

Medford, Massachusetts, in lat. 42° 25′ N., long. 71° 7′ W., is on a small river in a valley surrounded by high hills. It was settled and incorporated as a town in 1630.

Water-works were built by the town in 1870, after the plans of Shedd & Sawyer, civil engineers, taking the supply from Spot Pond, a natural lake of 296 acres area, and about 2 square miles watershed, 130 ft. higher than the town, to which the water is conveyed through 2 miles of 12-in. wrought-iron and cement pipe. Distribution is through 30 miles of the same kind of pipe, from 10-in. to 2-in. diameter, with 152 fire hydrants, 258 gates, 2,535 taps and 9 meters. The town pays $3,000 per year for street sprinkling and fountains.

The population in 1880 was 7,554. The daily consumption is not given.

The works have cost $320,000, and the gross receipts to Jan. 1, 1881, were $127,888.27. The bonded debt is $300,000, bearing interest at 6 per cent.

The expenses of maintenance were $4,138.52 in 1880, and $3,409.90 in 1881. The receipts in 1880 were $16,287.32, and in 1881 $16,566.18.

The works are managed by five commissioners. R. M. Gow is the Superintendent and C. B. Buss the Clerk.

CCI.—MAHANOY CITY.

Mahanoy City, Pennsylvania, in lat. 40° 43′ N., long. 76° 48′ W., is at the confluence of two small streams in a mountainous region. Settled in 1860, it was incorporated in 1861. Water-works were built in 1864 by a private company, under the direction of E. S. Silliman, taking the supply from springs and a stream on the Mahanoy Mountain, with a water-shed of 5 square miles. A dam 700 ft. long and 22 ft. high forms an impounding reservoir 350 ft. above and 1¾ miles from the city, to which the water is conducted through 10-in. cast-iron pipes.

Distribution is through 2½ miles of 6-in. and 3-in. cast-iron pipe, with 17 fire hydrants, 11 gates and 720 taps. The city pays $10 per year for each hydrant. The population in 1880 was 7,350. The daily consumption is not known.

The capital stock of the company is $56,250. The works have cost $78,500. The bonded debt is $1,800 at 6 per cent. Further financial statistics are not given. Edward S. Silliman is President of the company.

CCII.—EMPORIA.

Emporia, Kansas, in lat. 38° 23′ N., long. 96° 17′ W. is on the Cottonwood River.

Settled in 1857, it was incorporated as a city in 1870.

Water-works were built in 1880 by the city, after the plans of Russell and Alexander, taking the supply from a well 26 ft. in diameter and pumping directly into the mains, by a steam pump of 6-in. diameter and 21-in. stroke. The ordinary pressure maintained is 45 lbs., and the fire pressure 125 lbs.

Distribution is by cast-iron pipe of from 10-in. to 2-in. diameter, of which 12 miles are laid, with 43 fire hydrants, 41 gates and 187 taps. The town does not pay for hydrants.

The population in 1880 was 4,868. The daily consumption is not stated. The works cost $65,000, which is the amount of the bonded debt bearing 7 per cent. interest. Further financial statistics are not furnished. The works are managed by the Water Committee of the Council. D. Hammond is the Superintendent.

CCIII.—IONIA.

Ionia, Michigan, in lat. 43° N., long. 84° 55′ W., is on level ground at the foot of a bluff, ¾ mile from Grand River.

Settled in 1842, it was incorporated in 1875. Water-works were built by the city in 1876, after plans of George Briggs and James Bell.

The water comes from springs on the hill within the city limits, and passing through a marshy piece of ground for about a quarter of a mile is collected in a wooden tank, 44 ft. above the main street. It is distributed through ¼ mile of 10 in., ¾ mile of 8-in., and ½ mile of 4-in. cast-iron pipe with 8 fire hydrants and 100 taps.

The dam built to retain water has broken away twice, and the city counsel have refused to rebuild or repair it until a plan for permanent enlargement of the works is decided on.

The population in 1880 was 4,700. The daily consumption is not given.

The works have cost $17,000. There is no debt. The cost of maintenance in 1880 was $450, and the receipts $1,100 in 1880 and $1,900 in 1881. Frank C. Sibley is the Superintendent.

CCIV.—MALONE.

Malone, New York, in lat. 44° 51′ N., long. 74° 17′ W., is on the Salmon River, 11 miles from the Canada boundary, in an undulating country. Settled in 1805, it was incorporated as a village in 1853.

Water-works were built by a private company in 1857, taking the supply from three springs, from which the water is conducted by a 6-in. wrought-iron and cement pipe to a reservoir in earthwork, 60 by 30 ft. and 8 ft. deep, 75 ft. above the village. To insure a supply when the springs are low a dam of logs and planks has been built across a small branch of the Salmon River. The water used from this source is filtered through charcoal, sand and gravel before admission to the conduit.

Distribution is by 4¼ miles of wrought-iron and cement pipe of from 6 to 3-in. diameter, and 3½ miles 2-in. and 1-in. wrought-iron pipe, with 17 fire hydrants, 30 gates and 250 taps. The village pays $10 per year for each hydrant.

The population in 1880 was 4,300. The consumption is not stated.

The capital stock of the company is $45,000. The cost of the works is reported at that amount.

The receipts in 1880 were $6,000. Further financial statements are not given.

Benjamin Webster is the Superintendent.

CCV.—HINGHAM.

Hingham, Massachusetts, in lat. 42° 16′ N., long. 70° 54′ W., is on undulating ground on the shore of Massachusetts Bay. It was settled in 1630. Water-works were built by a private company in 1880, after the plans of Marshall M. Tidd, C. E., taking the supply from Accord Pond, a natural lake of 98 acres, 133 ft. above tide, reserving the drainage of about half a square mile. An old dam at the outlet was strenghtened by a concrete wall 2 ft. thick built in its centre. A 16 in. cast-iron pipe laid 80 ft. into the pond conducts the water to a screen well, whence it is distributed through 20 miles of wrought-iron and cement pipe of from 14-in. to 2-in. diameter, with 75 fire hydrants, 55 gates and 500 taps. Four meters are used. The town pays $1,500 per year for fire supply and water for the public buildings.

The population in 1880 was 4,324. The consumption is not known.

The capital stock of the company is $120,000. The works have cost $118,000, and the receipts, so far, have been about $10,000.

Charles W. S. Seymour is the Superintendent.

CCVI.—WAVERLEY.

Waverley, New York, in lat. 41° 59′ N., long. 76° 23′ W., is in a rolling country. A small stream flows through the village. Settled in 1840, it was incorporated as a village in 1855.

Water-works were built by a private company in 1880-1, after the plans of Peter Hogan, C. E. The supply is taken from a drainage area of about 2 square miles of cleared and cultivated lands, the water of which is impounded by an earth dam 50 ft. high and 150 ft. long. The outer slope is 1½ to 1 and the inner 2 to 1. A masonry wall 8 ft. thick and 35 ft. high is built in the center of the dam. A small leak occurred through a fissure in the rock around the end of the breast wall of the dam. The reservoir covers 10 acres, holds 58,000,000 gallons and is 100 ft. above the village.

Distribution is by 5 miles of cast-iron pipe of from 12 to 4-in. diameter; 2 miles being of the latter size. There are 28 fire hydrants, 25 gates and 90 taps. The town pays $1,825 per year for use of hydrants. Galvanized iron pipe is used for services.

The population in 1880 was 3,000. The daily consumption in 1881 was estimated at 250,000 gallons.

The capital stock of the company is $20,000. The works have cost $52,000. There is a bonded debt of $30,000 at 6 per cent.

The receipts to Jan. 31, 1882, were $3,700.

J. T. Sawyer is President and J. B. Floyd Secretary of the company.

CCVII.—GOUVERNEUR.

Governeur, New York, in lat. 44° 20′ N., long. 75° 20′ W., is on the Oswegatchie River, which rises in the Adirondack Mountains.

Founded in 1810, it was incorporated as a village in 1847.

Water-works were built by a private company in 1867, taking the supply from the Oswegatchie River, and pumping directly into the mains by rotary pumps built by the Holly Manufacturing Co. In 1878, Green rotary pumps were substituted for the original ones. The pumps are driven by water power from a dam on the river. The ordinary pressure maintained is 85 lbs. per square inch, and the fire pressure 80 to 90 lbs.

Distribution was at first by wrought-iron and cement pipe. Some trouble from breaks has been experienced, and cast-iron pipes are now used for extensions.

A mile and a half of pipe is in use, with 16 fire-hydrants, 7 gates and 89 taps, besides 3 fountains. The town pays $600 per year for the use of hydrants. The population in 1880 was 2,100. The daily consumption is not known. The works have cost $30,000. There is no debt. The expenses in 1880 were $500 and the receipts $1,600. Charles A. Van Duzer is the Superintendent.

CCVIII.—ST. LOUIS, MICH.

St. Louis, Michigan, in lat. 43° 25′ N., long. 84° 26′ W., is on Pine River, a small stream which flows through a rolling country richly timbered, and used extensively for water power for mills. Settled in 1858, it was incorporated in 1870.

Water-works were built by the city in 1879-80, after the plans of Stiles Kennedy. The supply is taken from the Pine River and pumped directly into the mains. For ordinary use a pressure of 28 to 35 lbs. is maintained by a pump driven by a 56-in. turbine. For fire pressure of 145 lbs., a steam pump with 5½-in. water cylinder of 12-in. stroke is used.

Distribution is by Wyckoff's wooden pipe, of which 1½ miles, of from 8-in. to 4-in. diameter, are laid, with 21 fire hydrants, 8 gates and 60 taps. Two meters are used.

The population in 1880 was 1,998. The daily consumption is not known.

The works cost $8,000. The bonded debt is $7,000 at 5 per cent. Further financial statements are not given.

Stiles Kennedy is President and Eugene King Superintendent of the company.

CCIX.—SLATINGTON.

Slatington, Pennsylvania, in lat. 40° 46′ N., long. 75° 33′ W., is on the Lehigh River. Trout Creek divides in into the upper and lower towns. Settled in 1850, it was incorporated as a borough in 1861, in which year water-works were built by a private company, taking the supply from springs collected in a covered reservoir 40 × 70 ft. In 1873, several additional springs were connected with the reservoir, furnishing a supply of about 30,000 gallons per day. This reservoir is 30 ft. above the upper town, and about 125 ft. above the lower town. In 1881, several other springs, lying 75 ft. above the town, were collected and brought into the reservoir, doubling the supply. The water comes from the slate formation, and is very pure.

Distribution is by cast-iron pipe, of which 3 miles are laid, of from 6-in. to 4-in. diameter, with 150 taps. There are no fire hydrants.

The population in 1880 was 1,680. The consumption is not stated.

The capital stock of the company is $6,000. The works have cost $10,000. There is a bonded debt of $10,000 at 6 per cent.

The expenses in 1880 were $100 and the receipts $900.

O. A. Neff is President of the company.

CCX.—PRAIRIE DU CHIEN.

Prairie du Chien, Wisconsin, in lat. 43° 3′ N., long. 91° 35′ W., is on a slightly rolling prairie about one mile wide, between the Mississippi River and high bluffs.

Settled in 1776 it was incorporated as a city in 1878. Water works were built by a private company in 1877, after the plans of Ira P. Brunson. The supply is taken from an artesian well of 6-in. bore and 975 ft. deep. The first 150 ft. is through sand and was at first cased with an iron pipe. This rusted out and was replaced with copper. The rest of the well is through rock. The water is strongly mineral and saline and is unfit for household use. It is discharged at the surface with a head equal to 55 ft. and led through 1,500 ft. of 6-in. cast-iron pipe in the main street, in which there are 6 fire hydrants and 40 taps. The city pays $22 per year for each hydrant.

The population in 1880 was 3,000. The consumption is not known.

The capital stock of the company is $5,000, which represents the cost of the work. The well cost $3,000.

The receipts have amounted to $2,600. In 1880 the expenses were $45 and the receipts $600.

Ira P. Brunson is the Superintendent.

(TO BE CONTINUED.)

The receipts of statistics as follows is acknowledged with thanks:

From G. W. Jones, City Clerk, statistics of the water-works of Litchfield, Ill. From A. H. Martine, Superintendent, eighth annual report of Watuppa Water Board, Fall River, Mass. From S. Y. Broadstreet, Superintendent, statistics of the water-works of Monticello, Ia. From J. Albert Mills, Superintendent, water rates and blank permits used in St. Catharines, Can. From Herbert B. Newhall, Chairman Construction Committee, statistics of the water-works of East Saugus, Mass. From Charles M. Storms, Water Commissioner, statistics of the water-works of Port Byron, N. Y. From Guy Kinne, President, statistics and water rates of the water-works of Richfield Springs, N. Y. From C. B. Buss, Clerk Water Board, statistics and water rates of the water-works of Medford, Mass., and annual reports 1872 to 1881. From C. A. Miller, Secretary and General Manager, statistics and water rates of the water-works of Susquehanna, Pa. From M. A. Gould, City Engineer, statistics of water-works of Moline, Illinois. From N. T. Sleeper, Secretary, statistics

of the water-works of Rockland, Maine. From Wm. Kirkham, Superintendent, statistics and water rates of the water-works of Petersburg, Va. From William F. Codd, Superintendent, statistics and water rates of the water-works of Nantucket, Miss. From J. H. Decker, Superintendent, statistics and water rates of the water-works of Hannibal, Mo. From A. J. McPike, Superintendent, statistics and water rates of the water-works of Vallejo, Cal. From C. W. Shippee, Secretary, statistics and water rates of the water-works of Milford, Mass. From Charles E. Fowler, Superintendent Poughkeepsie water-works, statistics of the water-works of Tarrytown, N. Y. From Jos. McChesney, Secretary, statistics of the water-works of Millville, N. J. From W. W. C. Sites, Chief Engineer, statistical figures of the Jersey water-works to Dec. 21, 1881. From E. P. Clark, Water Registrar, revised statistics of the water-works of Holyoke, Mass., with statement that J. D. Hardy is the Superintendent, and that E. C. Davis has not been connected with the works since 1873.

The request for statistics sent to Denison, Texas, is returned by W. J. Scott & Co., with the indorsement, "Local option not in force," which is supposed to mean that there are no water-works in that city.

CORRECTIONS, Feb. 11, 1882, p. 50. *Auburn, Me.*—For N. J. Jordan, read N. I. Jordan. *Louella, Pa.*—For Benjamin F. Shaw, read Benjamin F. Slaw. The same corrections are to be made in the acknowledgments on p. 51. *Chicopee, Mass.*—E. R. Stickney, Clerk Water Co., corrects history of the works by stating that the first supply from springs in 1845 was introduced by Charles McClallan. Stockwell Bettes designed the works built in 1877. The corrected statistics of Jersey City and Holyoke are as follows (see pp. 31 and 32, Jan. 28, 1882):

	JERSEY CITY.	HOLYOKE.	
Cost of construction to Jan. 1, 1882, excl. int. and maint.....	$4,938,493.21	Jan. 1, 1881..	$312,142.29
Bonded debt	$4,838,000.00		250,000.00
Daily consumption, 1881.....	15,879,285 galls.	1880..	2,000,000 galls.
Cost of maintenance, 1881	$66,078.20	" ..	$4,742.06
Revenue, 1881.....	$466,617.55	" ..	43,047.33
Miles of pipe, 1881	154.5	" ..	24.7
No. of fire hydrants, 1881.....	1,509	" ..	149
Head in ft., 1881.....	161.5		.....
No. of meters, 1881.	158	" ..	59

HYDRAULIC MOTORS.

A system of hydraulic motors has been introduced into the freight-stations of some English railways which presents many novel features. As every one knows, an immense amount of merchandise is handled at these stations, and it is necessary to provide accommodations for receiving and dispatching a large number of cars during the 24 hours. With us this would be done by securing ample yard room and filling it with parallel tracks and switches; but ground in London and Liverpool is costly, and the English managers of transportation are more careful than ours to keep the goods entrusted to them protected from the weather, so that it is found more satisfactory to build the structures for the reception and delivery of freight at the more important points in two stories, hoisting the cars bodily from one to the other, to be loaded or discharged. Moreover, space is found to be saved by arranging the tracks for the storage of cars not immediately needed for use transversely to the main tracks, from which they are shifted by means of rows of turn-tables, which will take six or seven cars at once from a train and transfer them to their proper places without the tedious hauling of the whole train back and forth over the switches, by which the same object is generally accomplished here, and the transfer of single cars, for which our yard-masters would have to employ a locomotive, is there obtained by the aid of horses or special motors.

For such applications of a moderate power at any desired point the hydraulic motor is found very suitable. The power is derived from one or two accumulators on the Armstrong principle, in which water is pumped into a cylinder under a piston loaded with a weight of 30 or 40 tons, furnishing a constant pressure, which is transferred to any part of the freight-yard, or indeed to a greater distance, by means of iron pipes laid underground, beyond the reach of frost. The conversion of this force into motion at the desired points is effected by capstans, similar in everything except size to some of our familiar water-motors, and supplied like a hydrant by a simple valve with a long stem. Posts with revolving caps, like horizontal pulleys, serve to transmit the power in any required direction, and three men, of whom one manages the capstan, the second runs with the rope and hook from place to place, and the third stops the cars at the required point by means of the brake, can move safely 150 or 200 cars every 24 hours. The raising of the loaded cars to the store-rooms in the lofts of the freight-houses is accomplished by hydraulic elevators of simple construction, and the water, after having performed its work, is returned to the accumulator to receive a new charge of force. The main supply-pipe is arranged to form a complete circuit, the water in which is always, by hydrostatic law, under nearly the same pressure as in the accumulator, a small loss being caused by friction. Each machine, whether capstan or elevator, takes its supply from the main circuit through a short branch pipe, which is furnished with a valve so that any machine can be cut off for repairs without affecting the operation of others, and an air-cushion attached to the main conduit prevents water-hammer in the pipes from action of the machines. The pipes are made of cast iron, put together with sleeve-joints packed with gutta-percha and secured by bolts, and tested to about three times the actual working pressure. With our acknowledged skill in making and putting together wrought-iron pipes, it seems as if the hydraulic conveyance of power might be found very useful in this country. The capstans are estimated to furnish from 80 to 85 per cent. of the power developed in the accumulator, so that this mode of transmission compares not unfavorably in point of economy with that by means of belts or gearing, while it is in many ways much more convenient. There is no limit to the distance to which power can be carried, and by the introduction of the cheap and simple hydraulic motors now used all steam engines, shafting, pulleys and belts might be banished from manufacturing establishments of the lighter class, to be replaced by one or two lines of pipe, supplied from a street main, and controlled by stop-cocks in a way which is very favorable to precision in workmanship. Already such a system has been introduced into one or two towns of Yorkshire, and the principle is capable of very wide application. Of course any form of hydrostatic pressure could be substituted for that produced by the action of pumps with the same result.—*American Architect and Builder.*

THE TIMBER SUPPLY OF THE UNITED STATES.

One of the most novel and interesting features of the census of 1880 is the map and statistics of the timber supply of the country, prepared by Professor Sargent, of Harvard, who is the special agent to collect statistics relative to forestry. The maps are the most interesting feature, presenting as they do not only the extent of the territory in States where there are forests valuable for timber, but those portions of the timber land which have been cut over. Nothing finer than the execution of this map work can be found, while the facts relative to location, character of the timber, its availability for market, give an idea of the magnitude of the work which Professor Sargent has performed. The bulletins and maps relating to forestry which have been issued thus far relate to those large tracts of pine timber to which the country must look for its main supply of this valuable wood. Thus far the maps cover seven States. The following are the feet of merchantable pine (board measure) standing May 31, 1880, in these States, together with the number of feet cut during the census year ending with that date:

States.	Standing pine. Feet.	Cut census year 1880. Feet.
Texas.....	67,508,500,000	174,440,000
Wisconsin.....	41,000,000,000	2,007,299,000
Michigan.....	35,000,000,000	4,497,211,000
Mississippi.....	23,975,000,000	115,775,000
Alabama.....	21,192,000,000	245,396,000
Florida.....	6,615,000,000	208,056,000
Minnesota.....	6,100,000,000	540,977,000

Probably future bulletins will give the extent of pine land in other States as well as statistics relative to the supply of valuable timber of other kinds, but the above figures show (first) that the pine States in the South contain the greater amount of timber, and (second) that the pine in Northern States is being cut much more rapidly than in the South. At the rate of the cutting of 1880, without making allowance for the increase by growth, Wisconsin's supply will last less than twenty years; Michigan's seven years, and Minnesota's less than twelve years. At this rate the South must furnish the greater part of the pine lumber in 1890.

CONTRACT AND SPECIFICATIONS FOR THE CONSTRUCTION OF THE YOUGHIOGHENY BRIDGE, McKEESPORT, PA.

Continued from Page 55.

masonry shall not exceed two hundred (200) pounds per square inch.

36. *Friction Rollers.*—All spans except trestle spans shall have at one end nests of turned friction rollers formed of wrought iron, running between planed surfaces. The rollers shall not be less than two and one-half ($2\frac{1}{2}$) inches in diameter, and shall be so proportioned that the pressure per lineal inch of rollers shall not exceed the product of the square root of the diameter of the roller in inches multiplied by five hundred (500) pounds ($500\sqrt{d}$.). Trestle spans to have expansion provided for at ends of the plate girders.

37. *Camber.*—The camber for the ninety (90) feet spans to be one (1) inch; for the two hundred and thirty-six (236) feet span. three (3) inches, and for the one hundred and thirty-seven (137) feet six (6) inch spans, two (2) inches.

QUALITY OF IRON.

1. All wrought iron must be tough, fibrous and uniform in character. It shall have a limit of elasticity of not less than twenty-six thousand (26,000) pounds per square inch; a variation of one-thousandth ($\frac{1}{1000}$) of an inch per foot will be considered a permanent set.

2. Finished bars must be thoroughly welded during the rolling, and free from injurious seams, blisters, buckles, cinder spots or imperfect edges.

3. For all tension members, the muck bars shall be rolled into flats and again cut, piled, reheated and rolled into finished sizes. They shall stand the following tests:

4. *Tension Tests.*—Full-sized pieces of flat, round or square iron, not over four and one-half ($4\frac{1}{2}$) inches in sectional area, shall have an ultimate strength of not less than fifty thousand (50,000) pounds per square inch, and stretch twelve and one-half ($12\frac{1}{2}$) per cent. in their whole length. Bars of a larger sectional area than four and one-half ($4\frac{1}{2}$) square inches, when tested in the usual way, will be allowed a reduction of one thousand (1000) pounds per square inch, for each additional square inch of section, down to a minimum of forty-six thousand (46,000) pounds per square inch.

5. When tested in specimens of uniform sectional area of at least one-half ($\frac{1}{2}$) square inch for a distance of ten (10) inches, taken from tension members which have been rolled to a section not more than four and one-half ($4\frac{1}{2}$) square inches, the iron shall show an ultimate strength of not less than fifty-two thousand (52,000) pounds per square inch and stretch eighteen (18) per cent. in a distance of eight (8) inches.

Specimens taken from bars of a larger cross section than four and one-half ($4\frac{1}{2}$) inches will be allowed a reduction of five hundred (500) pounds for each additional square inch of section down to a minimum of fifty thousand (50,000) pounds.

6. The same-sized specimen taken from an *angle* and other shaped iron shall have an ultimate strength of not less than fifty thousand (50,000) pounds per square inch, and elongate fifteen (15) per cent. in eight (8) inches.

7. The same sized specimen taken from *plate* iron shall have an ultimate strength of not less than forty-eight thousand (48,000) pounds per square inch, and elongate fifteen (15) per cent. in eight (8) inches.

8. *Bending Tests.*—All iron for tension members must bend cold for about ninety (90) degrees to a curve whose diameter is not over twice the thickness of the piece, without cracking. At least one sample in three must bend one hundred and eighty (180) degrees to this curve without cracking. When nicked on one side, and bent by a blow from a sledge, the fracture must be nearly all fibrous showing, but few crystalline specks.

9. Specimens from *angle*, *plate* and *shaped* iron must stand bending cold through ninety (90) degrees, and to a curve whose diameter is not over three (3) times its thickness without cracking, when nicked or bent its fracture must be mostly fibrous.

10. *Rivets and Pins.*—Rivets and pins must be made from the best double refined iron.

11. *Cast Iron.*—The cast iron must be of the best quality of soft gray iron.

Tests and Inspection.—All facilities for inspection of iron and workmanship shall be furnished by the contractor. He shall furnish, without charge, such specimens (prepared), of the several kinds of iron to be used as may be required to determine their character.

13. Full-sized parts of the structure may be tested at the option of the chief engineer, but if tested to destruction such material shall be paid for at cost, less its scrap value, to the contractor, if it proves satisfactory. If it does not stand the specified tests, it will be considered rejected material, and be solely at the cost of the contractor.

WORKMANSHIP.

1. All workmanship shall be first-class in every particular.

2. Abutting joints in truss bridges shall be in exact contact throughout.

3. Bars which are to be placed side by side in the structure shall be bored at the same temperature, and of such equal length, that upon being piled on one another the pins shall pass through the holes at both ends without driving.

4. Whenever necessary for the protection of the thread, provision shall be made for the use of pilot nuts in erection.

PAINTING.

1. All work shall be painted at the shop with one good coat of selected iron ore paint and pure linseed oil.

2. In riveted work, all surfaces coming in contact shall be painted before being riveted together. Bed plates, and all parts of the work which will not be accessible for painting after erection, shall have two coats of paint.

3. Pins, bored pin holes and turned friction rollers shall be coated with white lead and tallow before being shipped from the shop.

4. After the structure is erected, the iron work shall be thoroughly and evenly painted with two additional coats of paint, mixed with pure linseed oil, of such color as may be directed, the tension members being, however, generally, of lighter color than the compression members.

FINAL TEST.

1. Before the final estimate is made, a thorough test of the structure will be made by the chief engineer, by loading each span with the previously stated rolling load at a speed, approximately, of fifteen (15) miles per hour, and also by causing the load to remain on each span an hour or more.

2. Each span must not deflect under such strains more than one-half the camber above mentioned, and no permanent change shall take place in the whole or any part of the structure.

3. The final test will be as follows: A train made up of two (2) consolidation engines and followed by a train weighing one gross ton per foot, running at a speed of fifteen (15) miles per hour. Air or hand brakes may be applied to engines and cars when on any part of any span.

GENERAL CONDITIONS.

1. Inspectors appointed by the chief engineer of * * * will inspect the materials at the mills, supervise all work while in progress at the shops and erection at bridge sites, and all tests to be made.

2. All facilities for examining the stock and methods of manufacture shall be offered the inspectors. They shall be kept duly posted during the different stages of the work, and notified ahead whenever the iron is to be rolled and shipped.

3. All parts of the structure must be inspected and stamped by an inspector before shipment is made.

4. The contractor will be required to make good, at his own expense, any defect discovered at any time before the final payment is made, notwithstanding previous inspection and approval, unless the attention of the inspector shall have been previously called to such defect, and his allowance of it obtained in writing.

5. The said * * * shall not be held responsible for any delay of work caused by the rejection of materials or workmanship of detailed or finished parts of the structure, when such rejection is due to a violation of these Specifications or Conditions.

6. Contractors will submit with their proposals a full set of drawings (in large scale on sheets, size 23 × 31 inches), showing all the parts of the structure as they propose to erect it, giving sufficient information that an intelligent idea can be formed of all the minute details of the same; and as soon after as possible (not exceeding sixty (60) days), after said proposal is accepted and contract entered into, a full set of strain sheets, general and detail drawings or plans, showing the details of each part of the structure, must be submitted to the Chief Engineer for his acceptance and approval; and at all times during the progress of the work the Contractor must be prepared to furnish the Chief Engineer with such plans, drawings and strain sheets of the structure as he may require.

7. No work shall be commenced on any part of the structure until plans of said work shall have the signature of the Chief Engineer thereon.

8. Contractors in submitting their proposals must give the distance required from the base of rail to the top of coping of each pier and abutment.

9. AND THE SAID * * * doth promise and agree to pay the said * * * or completing the work provided for in this contract in accordance with the specifications and conditions herein set forth, and to the satisfaction and acceptance of the Chief Engineer * * *

10. On or about the first day of each month during the progress of this work, an estimate shall be made, under and by the directions of the Chief Engineer, of all the material delivered at the bridge site that is to form part of the structure and of all the material put in place in the structure during the previous month; a certain price will be paid for cast iron, wrought iron and timber at the site, and for cast iron, wrought iron and timber in place; before any price is determined upon the contractor shall furnish to the Chief Engineer a detailed statement showing the weight of iron or feet board measure of timber in every member of the structure, and the total weight of iron and amount of timber in the structure, and from said statement the Chief Engineer will determine the prices at which said cast iron, wrought iron and timber shall be estimated, and upon his certificate of the amount being presented to the Treasurer of said * * * or such disbursing as * * * may appoint * * * per centum of the amount of said estimate shall be paid to said * * * on or before the * * * day of each calendar month; and when all the work embraced in this contract is completed agreeably to the specifications and in accordance with the direction and to the satisfaction and acceptance of the Chief Engineer, there shall be made a final estimate of said work agreeably to the terms of this contract, when the balance appearing due to the * * * shall be paid to * * * upon * * * giving to said * * * a release under * * * hand and seal, releasing and discharging * * * from any and all claim and demand whatsoever in any manner growing out of this contract, and any and all cost, charge and expense connected therewith.

11. All materials that have been estimated and paid for, as aforesaid, are hereby declared to become the property of said * * * , but all such materials are in the charge of the contractor, and are entirely at the risk of the contractor; and said * * * shall in no way be held liable or responsible for any injuries to men, or to said materials, from fire, floods, collisions, or loss by decay or otherwise, during the manufacture, transportation or erection of said structure, until the work shall have been completed and accepted by the Chief Engineer.

12. The contractor shall conduct all his operations so as not to obstruct the navigation of the river.

13. The contractor shall furnish all staging, scaffolding and false work, and adjust all the work complete.

14. The within contract, specifications and prices are intended to cover all the work required for the complete finishing, as herein set forth, of all the superstructure of * * * as aforesaid; and under no circumstances shall any extra work or price be allowed: provided, however, if in any contingency the contractor should be required to do any work or furnish any materials which, in the opinion of the chief engineer, are not provided for in the contract, specifications or prices herein set forth, such work shall be done and such materials shall be furnished only upon a written order of the chief engineer, which order shall specifically set forth the work to be done or the materials to be furnished, the manner and time in which said work shall be done, and the prices for said work and materials.

15. The said * * * reserves the right to secure itself from all liability that might arise from the failure of the contractor to pay any and all claims whatsoever for which the said * * * would be legally liable. And the said * * * shall have the right to pay said claims and deduct the amount from any monthly estimate or estimates, and retain sufficient funds from any retained percentages for that purpose until the said * * * is satisfied that the said claims are paid.

16. The work embraced in this contract shall be carried on in such a manner and prosecuted with such rapidity as the Chief Engineer shall deem adequate for its completion within the time herein specified; and if at any time the contractor shall refuse or neglect to prosecute the work with energy sufficient, in the opinion of the Chief Engineer, for its completion within the time specified in this contract, then and in that case the Chief Engineer shall have the right to declare this contract, or any portion of the same, forfeited and void; and said * * * shall have the right to go on and complete said work, or any portion of the same, in such manner as * * * may deem best, and pay such prices or amounts of money as may be required for its completion in accordance with the contract and specifications herein; and said contractor shall be responsible and liable, and hereby agrees to pay to said * * * all sums of money which said * * * may have to pay for the completion of said work, as aforesaid, over and above the contract price or prices herein set forth for its completion by said contractor.

17. And it is mutually agreed and distinctly understood that the decision of the Chief Engineer shall be final and conclusive in any dispute which may arise between the parties to this contract relative to or touching the same, or touching the quality, quantity or value of any work done under this contract: and each and every of said parties do hereby waive any right of action, suit or suits, or other remedy in law or otherwise, by virtue of said covenants, so that the decision of said Chief Engineer shall, in the nature of an award, be final and conclusive on the rights and claims of said parties hereto.

18. Wherever the words Chief Engineer or pronouns relating to the same are used in this contract or specifications herein, it is understood to mean the Chief Engineer of said * * * whose orders, directions or instructions may be given in person or through such assistants or inspectors as he may appoint. Wherever the word Contractor or pronouns relating to the same is used in this contract or specifications herein, it is understood to mean * * *

In Witness Whereof, the parties hereto, do execute this Contract, dated the day and year first herein written.

[Bids for this bridge are to be addressed to J. Wainwright, Chief Engineer Pittsburgh, McKeesport & Youghiogheny Railroad, 77 Fourth avenue Pittsburgh, Pa., all bids to be in by March 1 next.]

LITERATURE.

THE ACTUAL LATERAL PRESSURE OF EARTHWORK.

BY B. BAKER, M. INST. C. E., LONDON.

(No. 56, Van Nostrand's Science Series.)

This valuable collection of experiments, or rather experiences, the result of observations gathered during the construction of some 43 miles in length of retaining walls of all kinds, under all circumstances of location and variety of foundation, is worth volumes of algebraic formulæ deduced from insufficient data derived from office experiments on a small scale, which at best can but give vague results and unsafe guides for practice.

In the discussion which followed the reading of this paper before the British Institute of Civil Engineers, it was suggested as a better title for the paper, "The Stability of Retaining Walls," as the scope of the paper developed the anomalous failure of heavy walls and the permanency of lighter structures, under apparently similar conditions, rendering the lateral pressure of the earth an unknown factor in either case, notwithstanding the care taken in the selection of formulæ expressive of it from the best existing authorities. He says, "Something must be assumed in any event, and it is far more simple and direct to assume at once the thickness of the wall than to derive the latter from equations based upon a number of uncertain assumptions as to the bearing power of the foundations, the resistance to sliding and other elements." "It has often struck the author that the numerous published tables giving the calculated required thickness of retaining walls to their places or decimals stand really on exactly the same scientific basis, and have the same practical value, as the weather forecasts for the year in old Moore's Almanack," or, as one of our old engineers is accustomed to characterize it, "guessing at half and multiplying it by two." He states as a significant fact "that, out of nine miles of retaining wall on the underground railway in London, the exceptionally weak wall should show, as it did, no movement, either during or after construction, while the exceptionally strong wall, though having six times the estimated stability of the former, should fail," and adds his convictions that the laws governing the lateral pressure of earthwork are not at present satisfactorily formulated.

The numerous examples of walls as built, given in this small volume, and their behavior, are very instructive, and our young mathematicians who know all about the thing would do well to carefully read this book before committing themselves to the accuracy of their differential calculus based upon insufficient data.

CORRESPONDENCE.

UNIFORM CONVENTIONAL TINTS.

RUTGERS COLLEGE, NEW BRUNSWICK, N. J.,
Feb. 11, 1882.

EDITOR ENGINEERING NEWS:

Have you in use at your institution a set of conventional tints for representing the various materials employed in mechanical, architectural and civil engineering constructions, as they have, for instance, at the Ecole Centrale des Arts et Manufactures at Paris? If so, will you please indicate them to me, and are they satisfactory?

The present confusion of tints in the practice of engineers, etc., in the books and in the schools is, at the least, unfortunate. Cannot this be remedied in time and is not the proper place to begin in the schools of engineering? If these can agree upon and adopt a set of tints by correspondence or in convention the beginning will have been made. Will you unite in such a movement? At present I use the tints adopted at the Ecole Centrale.

Very truly, ISAAC E. HASBROUCK,
Professor Mathematics and Graphics.

[We will be pleased to render such service as we can in the above matter.—EDITOR ENGINEERING NEWS.]